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Effect of Cowdung Compost Manure Rates of Application on the Growth and Leaf Yield of Spider Plant (*Cleome gynandra* L. Briq) in Jalingo, Taraba State, Nigeria

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Authors' contributions

This work was carried out in collaboration between all authors. Author YAG designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author JOS managed the analyses of the study. Author RJ managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Aim: The aim of the experiment was to evaluate the influence of different cowdung manure rates of application on growth and leaf yield performance of spider plant (*Cleone gynandra* L.).
Study Design: The experiment was laid out in a randomized complete block design (RCBD) with four treatments including the control replicated five (5) times.
Place and Duration of the Study: The field trial was conducted at the Teaching and Research Farm of Crop Science Department, Taraba State College of Agriculture Jallingo (Latitude 80°50" N and longitude 11°50" E) in 2014 and 2015 cropping seasons.
Methodology: Treatments were four rates of cowdung manure application viz: 0, 3.0, 6.0 and 9.0 tones/ha incorporated into the soil one week prior to sowing. Random soil samples were taken with

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a soil auger at 0 - 30 cm depth and analyzed using standard laboratory procedures to determine the pre-planting and post-harvest soil nutrient contents and physical characteristics of the study area.

Results: The results of soil analysis showed that the soil was acidic (pH(H_{2O}) 5.9) with sandy loam texture and of low fertility status. The composite soil sample in 2015 contained more nutrients than the initial contents except ECEC. The increments were: organic carbon (0.09 g/kg), total N (0.03 g/kg), and available P (0.10 mg/kg), while exchangeable Ca, Mg and K increased by 0.10, 0.10 and 0.02 cmol/kg respectively whereas ECEC was depleted by 1.25 cmol/kg. The results also indicated enhanced performance of treated plants in both cropping seasons. Significantly (P = .05) tallest plants which also produced the highest number of branches with thickest stems, largest leaves and highest leaf yield were obtained in plots fertilized with the highest cowdung manure rate (9.0t/ha) in both seasons. At this level of cowdung application, plant height, stem girth and leaf yield were 76.3 cm, 3.6 cm and 27.2 t/ha, respectively in 2014, while in 2015, the corresponding values were 76.3 cm, 3.5 cm and 27.6 t/ha.

Conclusion: The best crop response obtained at the highest cowdung manure rate could be an indication that higher yield is still possible at rates higher than 9.0 t/ha.

Keywords: Cleome gynandra; cowdung; growth performance; soil nutrient dynamics.

1. INTRODUCTION

Spider plant (*Cleome gynandra* L.) also known in various areas as African cabbage, Cat's wiskers, Spider flower, Bastand mustard and as Gashiya (Hausa) belongs to the family *Capporaceae* which comprises of 150 – 200 species and about 50 of these occur in most countries of tropical Africa particularly East Africa which is speculated to be the most probable center of origin of the crop [1,2,3,4]. It is a wild African native green leafy vegetable harvested largely from the wild in rural communities in sub-Saharan Africa, Asia, Thailand and the Americas though limited commercial cultivation is carried out in several countries in East and Southern Africa [5]. The spider plant is a fast-growing hardy native plant, and can tolerate harsh environmental conditions and thrives in sandy and degraded soils making it important in food security for rural populations.

Spider plant is local vegetable with multiple uses and high nutritional profile. The seed is rich in polyunsaturated oils of about 29.6% [6] and the leaves and tender shoots are high in vitamins, beta-carotene and vitamin C, calcium, protein, magnesium, micronutrients and powerful anti-oxidants. The crop can supply 72% of the daily recommended vitamin A requirement and this makes the crop a major contributor to a healthy diet for many rural Africans with limited food budgets and access to economic opportunities [7,8,9].

The crop has high quality medicinal value with multiple health benefits. It is commonly used in traditional medicine as a pain killer and to induce labour in childbirth and also to increase lactation in nursing women. The herb has been in use for ages in ethnomedicine in many traditional societies to alleviate common ailments like migraine, headache, nausea, vomiting, diphtheria, pneumonia, stomach disorder, arthritis, ulcers and malaria [1,10,11,12].

Spider plant leaves produce compounds that have strong repelling activity against most insects and bacteria and the crop is frequently intercropped with food crops and vegetables to repel insect pests and to control bacteria pathogens in cultivated crops. The spider plant seed oil also has insecticidal property and is occasionally used as an insecticide especially against ticks on organic animal farm [1,2,13].

Organic fertilizer is naturally occurring fertilizer including compost and manure. Composted manures as organic fertilizer especially composted cowdung manure which is abundant in the cattle rearing areas can increase spider plant yield by influencing leaf growth and chlorophyll content. Lack of fertilizer use is one of the factors that contribute to the low leaf yield of spider plant.

Despite the long-term recognition of the health and economic benefit of spider plant, little or no effort has been made by researchers and policy makers to domesticate the crop for increased productivity in Nigeria [14]. With increasing pressure on arable land due to population explosion, the ecological niches of the vegetable are fast disappearing, and this has accelerated large scale genetic erosion of this high value

native plant and future availability is highly threatened if no effort is made to save the crop. This work was therefore embarked upon to provide improved agronomic package that would ensure increased and sustainable production of *C. gynandra* to maximize the multiple benefits of the crop in Nigerian rural communities in Jalingo.

2. MATERIALS AND METHODS

2.1 Description of the Study Area

This study was carried out under irrigation in 2014 and 2015 at the Nukkai Irrigation Teaching and Research Farm of Crop Science Department, Taraba State College of Agriculture Jalingo (Latitude 80° 50" N and Longitude 11° 50" E) which lies in the Northern Guinea savannah region of Nigeria experiences an average annual rainfall of 700-1000mm from April-July and August-November, with peaks in August and September.

2.2 Experimental Design and Treatment Allocation

The treatments consisted of four levels of cowdung (0, 3.0, 6.0 and 9.0 tonnes/ha) laid out in a randomized complete block design (RCBD) with five replications.

2.3 Field Study

Clearing and ploughing of the trial field was carried out manually using cutlass and hoes. Sunken seedbeds were used and each measured 2 m x 3 m (6 m^2). Prior to seedbed preparation, representative soil samples were collected at 0 – 30 cm depth using a soil auger and bulked to form a composite sample. The soil was air dried in the laboratory and grounded to fineness and sieved through 2-mm mesh before using for routine analysis following the prescribed standard analytical procedures [15].

Cowdung manure sourced from the College dairy farm was incorporated into the soil during the land preparation one week before sowing during which the beds were watered 3 times before sowing of the seeds which were sourced from local seed banks in the area. Seeds were mixed with sand and then drilled in rows spaced 30 cm apart. At 2 weeks after emergence, the seedlings were thinned to one plant per stand at 20 cm intra-row spacing. All normal agronomic management practices such as land preparation, weeding, manure application, pest and disease control, erosion control, etc were followed to ensure good crop growth.

2.4 Harvesting, Data Collection and Analysis

Harvesting of the fresh shoots was carried out at 2 weeks intervals commencing from 10 weeks after planting (10 WAP) and terminated at 20 WAP. Parameters measured sampled plants were plant height, number of branches, stem girth, leaf area, all at flowering, while fresh leaf yield was determined from the summation of leaf yield at the end of harvest. Leaf area was determined using the formula: LA = 0.76 L x 0.34 W. Where LA = Leaf Area (cm^2), L = Leaf length (cm), W = Leaf width (cm), 0.34 and 0.76 are constants [16]. Data collected were subjected to analysis of variance (ANOVA) and means separation was done using the Fisher's least significant difference (LSD) at P = 0.05.

3. RESULTS AND DISCUSSION

Analysis of the physico-chemical characteristics of the surface soil samples at the site during the period of the experiment showed high, moderate and low sand, silt and clay contents respectively indicationg a sandy loam texture (Table 1). The sandy nature of the soil indicated its limited ability to retain water and nutrients unlike soils with large amounts of clay or organic matter which tend to have higher tenacity to retain nutrients against leaching. The moderate silt content of the soil suggests that its agricultural potential could be improved by adoption of appropriate soil management and cropping practices.

The chemical analysis of the soil showed that the soil was moderately acidic in both cropping years. Soils with this level of acidity if managed properly could support sustainable productivity. High soil acidity has many adverse effects on both major and micro-nutrients. In acid soils nitrogen, phosphorus, potassium, sulfur, calcium magnesium, and molybdenum may be unavailable, while the likelihood of aluminum and manganese toxicity is usually high [17]. The acidic nature of the soil implies that liming could be carried to raise the pH to between 5.5 (medium acidity) and 7.5 (very slightly alkaline), a range preferred by most crops as essential nutrients are readily available in absorbable forms to plant [18].

The soil at the experimental site contained organic carbon, total nitrogen and nutrient elements at levels considered low, indicating low fertility status. Nutrient deficient soils deteriorate easily especially in continuous cultivation and require appropriate management to enhance and sustain their productivity [19].

The effect of different rates of cowdung manure on plant height, number of primary branches and stem girth in 2014 and 2015 were significant as shown on Table 2. Plant height increased as manure rates were increased with the tallest plants in plots incorporated with the highest rate of cowdung (9.0 t/ha), while plants in the control plots were shortest at the two sampling periods in both years. The tallest plants produced the highest number of branches with largest stem girth and plants in the control plots had fewest branches which also had smallest stem girth during the same period.

Increased plant height and high proliferation of branches in plants fertilized plots indicated good crop growth obviously due to the beneficial effect of cowdung compost manure on the soil. Organic manures have been reported to contain beneficial microorganism that digest organic matter into humus and mineralized nutrients in the soil and form symbiotic association with plants for enhanced crop health and productivity [20,21].

Plant leaf growth and expansion increased significantly (P = 0.05) from plants in zero manure plots and maximized in plants in plots treated with the highest manure rate in both seasons. Plants fertilized with 9 t of cowdung manure had the largest leaf surface area which was higher by 25.81, 18.17 and 12.08 cm^2 than plants in the control plots and those in plots fertilized with 3 and 6 t of manure, respectively in 2014, while in 2015 the differences in the leaf sure area in the corresponding treatments were 24.28, 15.72 and 10.28 cm^2.

Fresh leaf yield was also influenced by cowdung compost manure and like other parameters, it also increased significantly (P = 0.05) with each incremental rate of manure applied and maximize at the maximum manure rate, while plants in control plots had the least values for the parameter in the two cropping seasons (Table 3). The highest fresh leaf yield was produced in plots fertilized with cowdung manure at 9 t/ha, followed by 6, and 3 t/ha while unfertilized plots produced the lowest fresh leaf yield. The fresh leaf yield increased by 8.4, 12.8 and 14.7 t/ha by applying cowdung manure at 3, 6 and 9 t/ha respectively, representing the corresponding increase of 67.2, 99.2 and 117.6% above the plants in control plots in 2014. A similar trend was obtained in 2015.

The amount of nutrients released into the soil depends largely on the quantity and quality of organic manure and other factors. The highest rate of cowdung compost manure application released more nutrients than other rates and this might have been responsible for the best performance of plants in that treatment. Similar observations have been reported by [22].

Who obtained the best growth and highest fruit yield in okra in plots fertilized with the highest rates of organic manure.

Table 1. Some pre-planting and post-harvest physico-chemical properties of soil at the experimental site (2014 and 2015)

Parameters	2014	2015
Sand (%)	63	63
Silt (%)	23	23
Clay (%)	14	14
Texture	**Sandy loam**	**Sandy loam**
pH 1:2.5 (H_2O)	5.9	5.9
pH 1:2.5 ($CaCl_2$)	5.2	5.2
Organic carbon (g kg^{-1})	2.80	3.70
Total N (gkg^{-1})	0.65	0.68
C/N ratio	4.31	5.41
Available P (mg kg^{-1})	2.10	2.20
Exchangeable calcium (cmol kg^{-1})	2.10	2.20
Exchangeable magnesium (cmol kg-1)	0.70	0.80
Exchangeable potassium (cmol kg-1)	1.88	1.90
Exchangeable sodium (cmol kg-1)	1.89	1.90
Effective cation exchange capacity (cmol kg-1)	6.57	8.80

Table 2. Effect of cowdung compost manure rate on plant height, number of branches and stem girth of *C. gynandra* at 8 WAP

Manure rates (t/ha)	Plant height (cm)		Number of branches		Stem girth (cm)	
	2014	2015	2014	2015	2014	2015
Control	47.6	47.9	3.0	3.1	1.4	1.5
3.0	64.8	65.3	4.3	4.5	2.6	2.7
6.0	69.7	69.9	6.1	6.3	3.1	3.2
9.0	76.8	76.4	7.3	7.7	3.6	3.5
$LSD_{(0.05)}$	2.11	2.10	0.06	0.05	0.12	0.14

Table 3. Effects of cowdung compost manure rates on leaf area and fresh leaf yield of *C. gynandra* in 2014 and 2015 cropping seasons

Manure rates (t/ha)	Leaf area (cm^2)		Fresh leaf yield (t/ha)	
	2014	2015	2014	2015
Control	4.90	5.60	12.5	12.6
3.0	12.54	14.16	20.9	20.8
6.0	18.63	19.60	24.9	25.1
9.0	30.71	29.88	27.2	27.6
$LSD_{(0.05)}$	0.22	0.21	0.95	0.93

4. CONCLUSION

Cleome gynandra responded differently to cowdung compost manure application with the highest fresh leaf yield obtained in plots that received the highest manure rate (9 t/ha) which could be an indication that higher yields might still be possible at rates higher than 9 t/ha.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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